NEOSHO RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: Council Grove Lake
Water Quality Impairment: Eutrophication

Subbasin: Neosho Headwaters

Counties: Morris, Wabaunsee, and Geary

HUC 8: 11070201

HUC 11 (HUC 14)**:** **010** (010, 020, 030, 040, 050, 060)

Ecoregion: Flint Hills (28)

Drainage Area: Approximately 258.6 square miles.

Conservation Pool: Area = 2,589 acres
Watershed Area:Lake Surface Area = 62:1
Maximum Depth = 11 meters (36 feet)
Mean Depth = 4.4 meters (14 feet)
Retention Time = 0.49 years (5.9 months)

Designated Uses: Primary and Secondary Contact Recreation; Expected Aquatic Life Support; Drinking Water; Industrial Water Supply Use; Food Procurement

Authority: Federal (U.S. Army Corps of Engineers), State (Kansas Water Office)

1998 303d Listing: Table 4 - Water Quality Limited Lakes

Impaired Use: All uses are impaired to a degree by eutrophication

Water Quality Standard: Nutrients - Narrative: The introduction of plant nutrients into streams, lakes, or wetlands from artificial sources shall be controlled to prevent the accelerated succession or replacement of aquatic biota or the production of undesirable quantities or kinds of aquatic life. (KAR 28-16-28e(c)(2)(B)).

The introduction of plant nutrients into surface waters designated for primary or secondary contact recreational use shall be controlled to prevent the development of objectionable concentrations of algae or algal by-products or nuisance growths of submersed, floating, or emergent aquatic vegetation. (KAR 28-16-28e(c)(7)(A)).

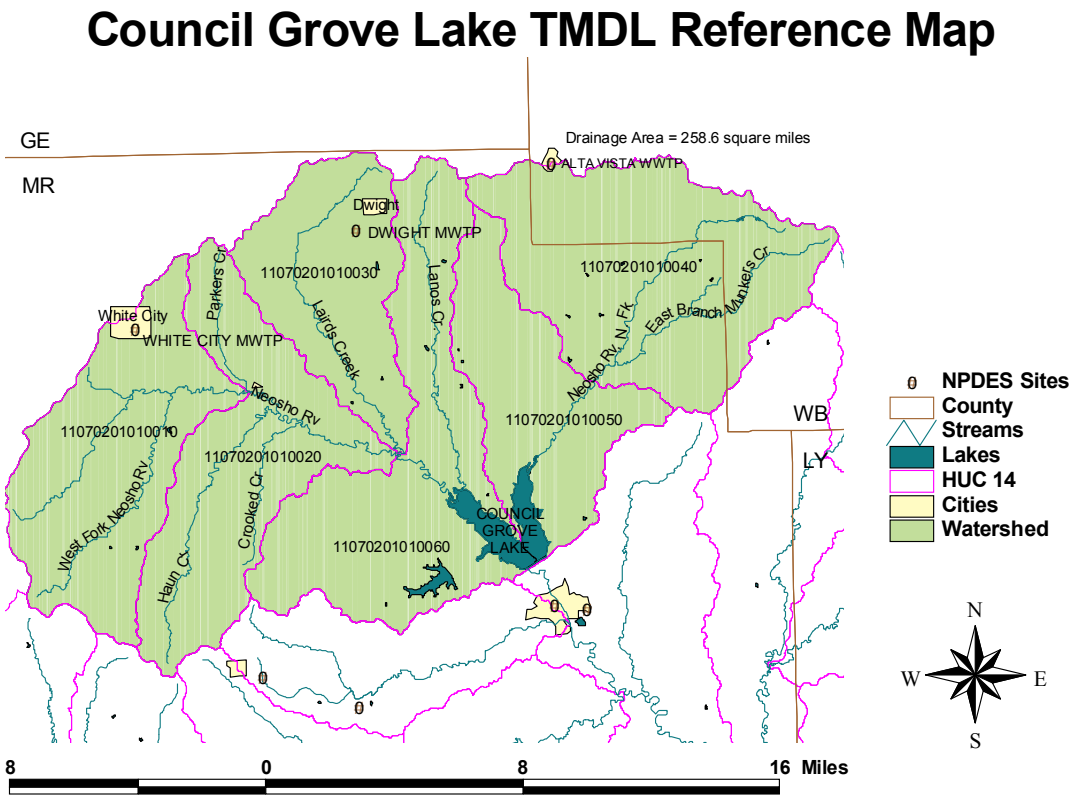
2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Eutrophication: Argillotrophic, Trophic State Index = 47.98

Monitoring Sites: Station 022001 in Council Grove Lake (Figure 1).

Period of Record Used: Five surveys during 1987 - 1999 and Kansas Biological Survey (2000)

Figure 1



Current Condition: Council Grove Lake has chlorophyll a concentrations averaging 5.90 ppb (Appendix A). This relates to a Trophic State Index of 47.98. Sampling done by KDHE shows elevated total phosphorus concentrations (averaging 212 ppb). One hundred percent of the samples are over 50 ppb. The Total Kjeldahl Nitrogen concentrations average 0.94 mg/L; nitrate concentrations average 0.52 mg/L; and nitrite is often below the detection limit. Light is indicated to be the primary limiting factor (Appendix B). Surface water in Council Grove Lake has high turbidity, dominated by inorganic materials because the lake receives a steady inflow of silt. Bioassays preformed by the Kansas Biological Survey indicate that nitrogen is the limiting nutrient. The chlorophyll a to total phosphorus yield is low; the algal production is reduced

because light cannot penetrate through the turbid water.

There is an accompanying TMDL for sediment in Council Grove Lake. The chlorophyll a levels will rise when the turbidity decreases and the Secchi disc depth increases, if current phosphorus and nitrogen levels in the lake are not reduced simultaneously. (See the Response Curve with Improving SDD graph in Appendix C). Because the nutrient concentrations in the lake are so elevated, algal blooms may be seen as the clarity improves even though measures are being taken to decrease the nutrient load. If the clarity (Secchi Disc Depth) of the lake does not improve, then a gradual decline in the chlorophyll a concentration will be seen. Assessment of the eutrophication impairment is based on modeling rather than direct measurement.

The Trophic State Index is derived from the chlorophyll a concentration. Trophic state assessments of potential algal productivity were made based on chlorophyll a concentrations, nutrient levels and values of the Carlson Trophic State Index (TSI). Generally, some degree of eutrophic conditions is seen with chlorophyll a concentrations over 7 μg/l and hypereutrophy occurs at levels over 30 μg/l. The Carlson TSI, derives from the chlorophyll concentrations and scales the trophic state as follows:

1. Oligotrophic TSI < 40
2. Mesotrophic TSI: 40 - 49.99
3. Slightly Eutrophic TSI: 50 - 54.99
4. Fully Eutrophic TSI: 55 - 59.99
5. Very Eutrophic TSI: 60 - 63.99
6. Hypereutrophic TSI: $\geq$ 64

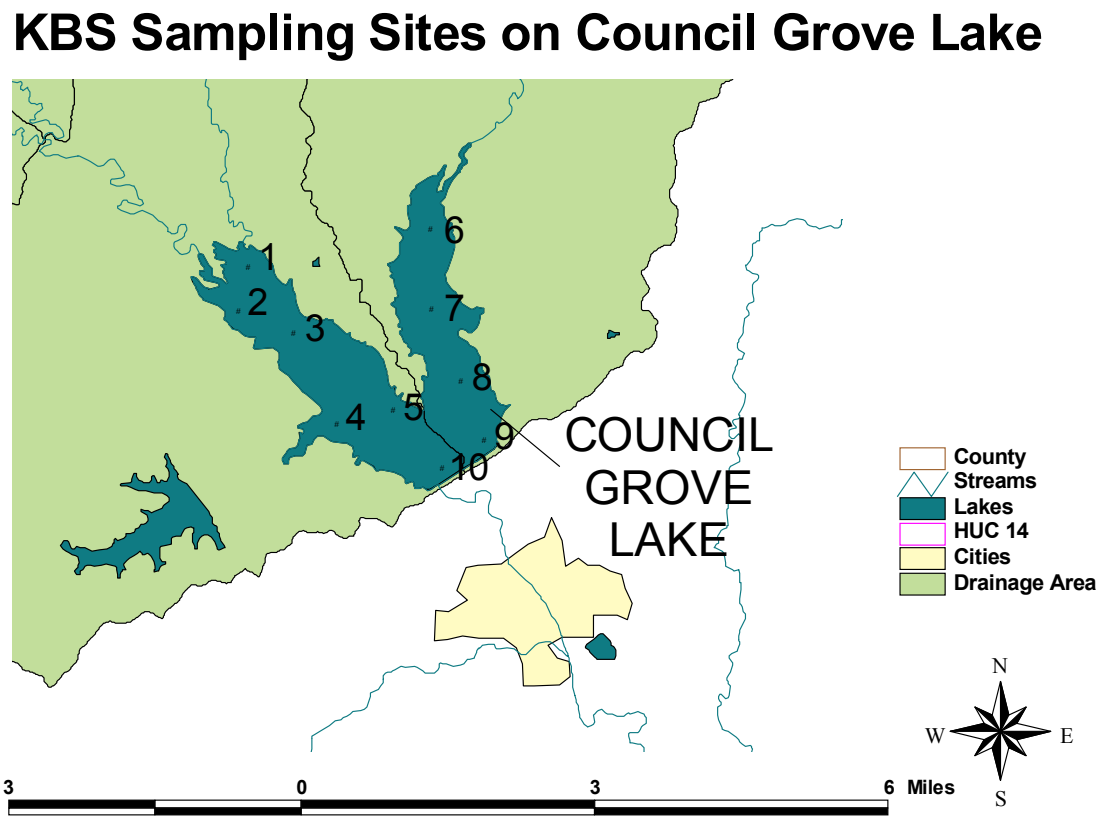
From May to November of 2000, the Kansas Biological Survey collected data monthly at ten stations (Figure 2) in Council Grove Lake. A summary of those results is included in the below table.

Averages of Kansas Biological Survey Samples at the Ten Stations

Location	**Total Phosphorus (μg/L)**	**Total Nitrogen (mg/L)**	**Chlorophyll a (μg/L)**
Lanos Creek (Station 1) - Riverine	**184**	**0.56**	**29.30**
Neosho River (Station 2) - Riverine	**212**	**0.57**	**28.24**
Neosho River Arm (Station 3) - Transitional	**168**	**0.48**	**27.44**
Canning Creek (Station 4) - Transitional	**164**	**0.43**	**24.28**
Neosho River Arm (Station 5) - Transitional	**161**	**0.43**	**22.97**
Neosho River, N. Fork (Station 6) - Riverine	**271**	**0.65**	**23.09**
Richey Creek (Station 7) - Transitional	**187**	**0.44**	**21.25**
Neosho Rv., N. Fork. Arm (Station 8) - Transitional	**152**	**0.41**	**22.05**

Main Basin (Stations 9 & 10) - Lacustrine	**153**	**0.37**	**14.11**
Lake Average in 2000	**184**	**0.48**	**23.6**

Figure 2



The data are converted to loads by the following method. To determine the inflow into both arms of the lake, the proportion of the subwatershed to the entire watershed was multiplied times the inflow data from the U. S. Army Corps of Engineers. The load was calculated by multiplying the subwatershed inflow times the average concentration times a conversion factor. From this calculation, it is evident that the Neosho River/Lanos Creek subwatershed is making the greatest contribution to the phosphorus and nitrogen load. This conclusion is consistent with the land use assessment, because the Neosho River/Lanos Creek Watershed has 2.7 times more cropland then the Neosho River, North Fork subwatershed.

Loads Calculated from the Kansas Biological Survey Sample Data

Location	**Drainage Area**	**Total Phosphorus Load**	**Total Nitrogen Load**
Neosho River/Lanos Creek (Station 3)	170 mile^2	2.9 lbs/day	8.4 lbs/day
Neosho River, North Fork (Station 7)	89 mile^2	1.7 lbs/day	4.0 lbs/day

Interim Endpoints of Water Quality (Implied Load Capacity) at Council Grove Lake over 2007 - 2011:
In order to improve the trophic condition of the lake from its current Argillotrophic status, the desired endpoint will be to maintain summer chlorophyll a concentrations below 12 μg/L. The Total Nitrogen concentration in the lake should be maintained below 0.62 mg/L. A regression of 2000 - 2001 lake data and 1997 - 2000 wetland data was used to determine the current, in-lake nitrogen concentration and to calculate how much of a nutrient reduction was need to meet water quality standards.

To ensure the clarity of the water, the desired Secchi disc depth endpoint will be summer average readings greater than 1 m in the main body of the lake near the dam. Both the chlorophyl a and Secchi disc depth endpoints must be met in order to comply with the Water Quality Standards.

3. SOURCE INVENTORY AND ASSESSMENT

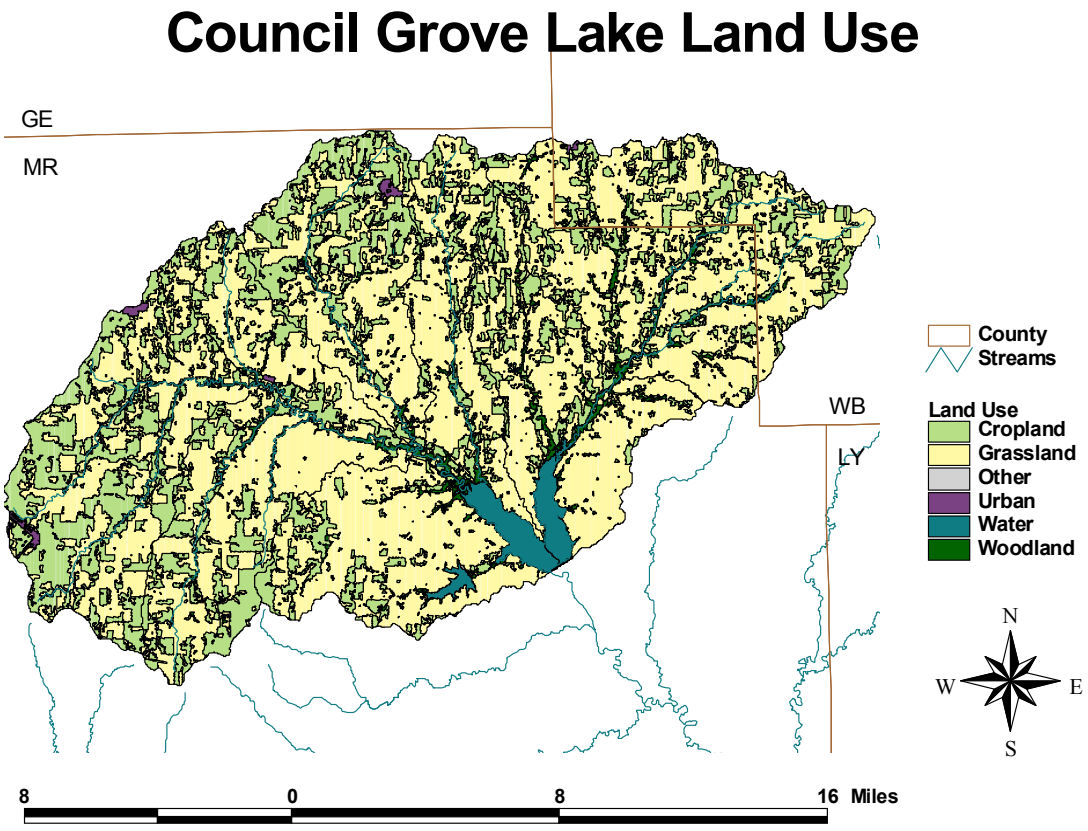
NPDES: Three NPDES permitted facilities are located within the watershed (Figure 1). Dwight WTP has no history discharge. White City WTP consistently discharges below their design flow. In compliance with their NPDES permit, White City samples for Biochemical Oxygen Demand, Total Suspended Solids, pH, and Ammonia. Phosphorus data are not available for either waste treatment plant. According to projections of future water use and resulting wastewater, both wastewater treatment plants look to have sufficient treatment capacity available. The Alta Vista WTP currently has a two-cell lagoon that discharges into the Kansas-Lower Republican River Basin; a three-cell lagoon that will discharge into the Council Grove watershed is now under construction. A three-cell lagoon may be going into the Council Grove City Lake watershed in the near future in order to remove the need for septic systems around the lake. The average Total Phosphorus concentration of lagoons, that meet baseline design criteria, is 2.0 mg/L. If this concentration is multiplied times the sum of the design flows and a conversion factor, then it would contribute an estimated 0.1% of total annual phosphorus load.

Waste Treatment Plants in the Council Grove Watershed

Name	Type	Design Flow (MGD)	Expiration Date
Alta Vista Wastewater Treatment Plant	3-cell lagoon in construction	0.054	2003
Council Grove City Lake	3-cell lagoon	0.09	Potential Project
Dwight Wastewater Treatment Plant	3-cell lagoon	0.07	2003
White City Wastewater Treatment Plant	3-cell lagoon in construction	0.053	2003

The cities within the watershed anticipate population growth between 2000 and 2020. The following population increases are expected: Alta Vista (+8.3%), Dwight (+2.1%), and White City (+8.4%). The average population density is low (7.6 people per square mile).

Figure 3



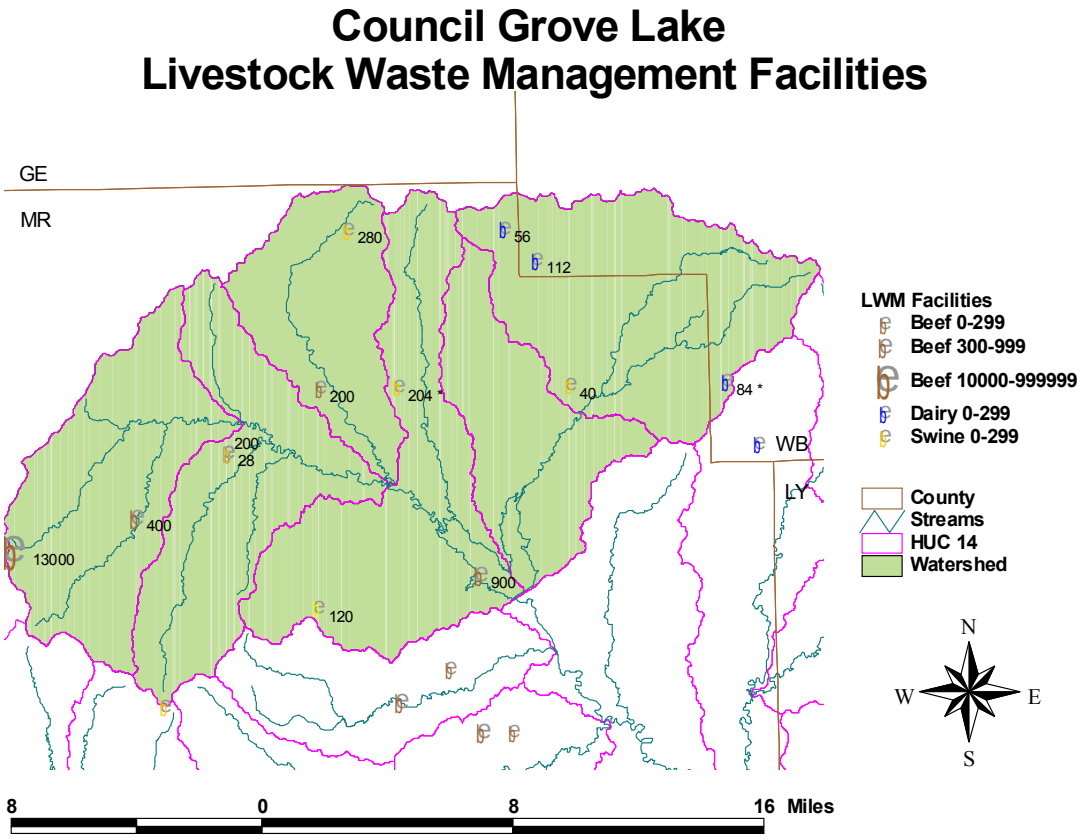
Land Use: The watershed around Council Grove Lake has a high potential for nonpoint source pollutants. An annual phosphorus load of 1,697,267 pounds per year (Appendix D) are necessary to correspond to the concentrations seen in the lake.

One source of phosphorus and nitrogen within Council Grove Lake is probably runoff from agricultural lands where phosphorus has been applied. Fifty-six square miles of cropland are located in the Neosho River/Lanos Creek subwatershed, and twenty-one square miles are located in the North Fork Neosho River subwatershed. Land use coverage analysis indicates that 29.8% of the watershed is cropland (Figure 3).

Phosphorus and nitrogen from animal waste is a contributing factor. Sixty-four percent of land around the lake is grassland; the grazing density of livestock is moderate. Animal waste, from confined animal feeding operations, adds to the nitrogen and phosphorus load going into Council Grove Lake (Figure 4). There are 3 dairy, 4 beef, and 6 swine animal feeding operations in the watershed. One beef facility in the watershed is NPDES permitted and non-discharging and has up to 13,000 animal units. All permitted livestock facilities have waste management systems designed to minimize runoff entering their operations or detaining runoff emanating from their

areas. Such systems are designed for the 25 year, 24 hour rainfall/runoff event, which would be indicative of flow durations well under 10 percent of the time. Such events would not occur at a frequency or for a duration sufficient to cause an impairment in the watershed.. Potential animal units for all facilities in the watershed total 15,624. Some of these facilities (accounting for 288 animal units) are inactive. The actual number of animal units on site is variable, but typically less than potential numbers.

Figure 4



Septic systems are located around the lake. The largest towns in the watershed are Alta Vista, Dwight, White City, and the Council Grove Lake community. Less than one percent of the watershed is urban; stormwater runoff and urban fertilizer applications are a minor contributing factor. All of the urban land is located in the Neosho River/Lanos Creek subwatershed. Failing septic systems can be a significant source of nutrients. The following number of septic systems is present within the counties: Geary (1202), Morris (1589), and Wabaunsee (1424). There are 350 septic tanks in the Council Grove Lake community and 90 full-time homes.

Contributing Runoff: The watershed's average soil permeability is 0.4 inches/hour according to NRCS STATSGO database. About 98.5% of the watershed produces runoff even under relatively low (1.5''/hr) potential runoff conditions. Runoff is chiefly generated as infiltration

excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.5"/hr of rain will generate runoff from only 48.2% of this watershed, chiefly along the stream channels.

Background Levels: Three percent of land in the watershed is woodland; leaf litter may be contributing to the nutrient loading. The atmospheric phosphorus and geological formations (i.e., soil and bedrock) may contribute to phosphorus loads. Nitrogen loads may be contributed from the atmosphere. Carp may cause some resuspension of sediment.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

While light is the limiting factor in Council Grove Lake, Total Phosphorus is also allocated under this TMDL, because a phosphorus reduction will have a large effect on the managing the algal community. The Load Capacity is 103,094 pounds per year of phosphorus. The Total Phosphorus Load Capacity was calculated using the CNET model. More detailed assessment of sources and confirmation of the trophic state of the lake must be completed before detailed allocations can be made. The general inventory of sources within the drainage does provide some guidance as to areas of load reduction. Because of atmospheric deposition, initial allocations of nitrogen will be based on a proportional decrease in nitrogen between the current condition and the desired endpoint.

Point Sources: This impairment is partially associated with the Waste Treatment Plants. Ongoing inspections and monitoring of these NPDES sites will be made to ascertain the contributions that have been made by the source. These Waste Treatment Plants should comply with any future permit limits. Because current estimated loads constitute 0.1% of the current Total Phosphorus annual load and because of the long travel distance between their outfall and the lake, no reduction in Total Phosphorus or Nitrogen Wasteload will be required at this time. The Wasteload will be calculated with the proposed Council Grove City Lake project. Therefore, the Wasteload Allocation should be at 1,627 pounds of total phosphorus per year. As previously noted in the inventory and assessment section, sources such as non-discharging permitted agricultural facilities located within the watershed do not discharge with sufficient frequency or duration to cause an impairment in the lake.

Nonpoint Sources: Water quality violations are predominantly due to nonpoint source pollutants. Background levels may be attributed to atmospheric and geological sources. The assessment suggests that cropland and animal waste contribute to the elevated total phosphorus and nitrogen concentrations in the lake. Generally a Load Allocation of 91,158 pounds of total phosphorus per year, leading to a 94% reduction, is necessary to reach the endpoint. A proportional decrease of 58% in nitrogen loading will allow the total nitrogen endpoint to be achieved.

Defined Margin of Safety: The margin of safety provides some hedge against the uncertainty of variable annual total phosphorus load and the chlorophyll a endpoint. Therefore, the margin of safety will be 10,309 pounds per year of total phosphorus taken from the load capacity subtracted

to compensate for the lack of knowledge about the relationship between the allocated loadings and the resulting water quality. For nitrogen, the margin of safety will be an additional 6% reduction in nitrogen to ensure that the endpoint is reached.

State Water Plan Implementation Priority: Because Council Grove Lake is a federal reservoir with a relatively small watershed and a large regional benefit for recreation and state invested water supply, this TMDL will be a High Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Neosho Headwaters (HUC 8: 11070201) with a priority ranking of 38 (Medium Priority for restoration).

Priority HUC 11s: The watershed is within HUC 11 (010). The Neosho River/Lanos Creek subwatershed should take priority. Secondary focus should be placed the Neosho River, North Fork subwatershed.

5. IMPLEMENTATION

Desired Implementation Activities

There is a very good potential that agricultural best management practices will allow full use support to take place in Council Grove Lake. Some of the recommended agricultural practices are as follows:

1. Implement soil sampling to recommend appropriate fertilizer applications on cropland.
2. Maintain conservation tillage and contour farming to minimize cropland erosion.
3. Install grass buffer strips along streams.
4. Reduce activities within riparian areas.
5. Implement nutrient management plans to manage manure application to land.

Implementation Programs Guidance

NPDES-KDHE

a. Begin to evaluate nutrient loading from municipal dischargers in the watershed.
b. Work with those dischargers on reducing their individual loadings.

Nonpoint Source Pollution Technical Assistance - KDHE

a. Support Section 319 demonstration projects, such as the Twin Lakes project in Morris County, for reduction of sediment runoff from agricultural activities as well as nutrient management.
b. Provide technical assistance on practices geared to establishment of vegetative buffer strips.
c. Provide technical assistance on nutrient management in vicinity of streams.
d. Update and implement nutrient and sediment abatement strategies.
e. Develop a Watershed Restoration and Protection Strategy for HUC 11070201.

Water Resource Cost Share Nonpoint Source Pollution Control Program - SCC

a. Apply conservation farming practices, including terraces and waterways, sediment control basins, and constructed wetlands.

b. Provide sediment control practices to minimize erosion and sediment and nutrient transport.

Riparian Protection Program - SCC

a. Establish or reestablish natural riparian systems, including vegetative filter strips and streambank vegetation.

b. Develop riparian restoration projects.

c. Promote wetland construction to assimilate nutrient loadings.

Buffer Initiative Program - SCC

a. Install grass buffer strips near streams, particularly by the Lanos Creek and the Neosho River.

b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance - Kansas State University

a. Educate agricultural producers on sediment, nutrient, and pasture management.

b. Educate livestock producers on livestock waste management and manure applications and nutrient management planning.

c. Provide technical assistance on livestock waste management systems and nutrient management plans.

d. Provide technical assistance on buffer strip design and minimizing cropland runoff.

e. Encourage annual soil testing to determine capacity of field to hold nutrients.

Time Frame for Implementation: Pollutant reduction practices should be installed within the priority subwatersheds during the years 2002-2007, with minor followup implementation, including other subwatersheds over 2007-2011.

Targeted Participants: Primary participants for implementation will be agricultural producers within the drainage of the lake. Initial work in 2002 should include local assessments by conservation district personnel and county extension agents to locate within the lake drainage:

1. Total row crop acreage
2. Cultivation alongside lake
3. Drainage alongside or through animal feeding lots
4. Livestock use of riparian areas
5. Fields with manure applications

Milestone for 2007: The year 2007 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, sampled data from Council Grove Lake should indicate evidence of reduced phosphorus levels in the conservation pool elevations relative to the conditions seen over 1987-1999.

Delivery Agents: The primary delivery agents for program participation will be conservation districts for programs of the State Conservation Commission and the Natural Resources Conservation Service. Producer outreach and awareness will be delivered by Kansas State Extension.

Reasonable Assurances:

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollutants.

1. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.

2. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

3. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.

4. K.S.A. 82a-901, et seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

5. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan.*

6. The *Kansas Water Plan* and the Neosho Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollutant reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are a High Priority consideration.

Effectiveness: Nutrient control has been proven effective through conservation tillage, contour farming and use of grass waterways and buffer strips. The key to success will be widespread utilization of conservation farming and installation of buffer strips within the watersheds cited in this TMDL.

6. MONITORING

Additional data, to establish nutrient ratios, source loading and further determine mean summer lake trophic condition, would be of value prior to 2007. Further sampling and evaluation should occur once before 2007 and twice between 2007 and 2011. Some monitoring of tributary levels of nutrients will help direct abatement efforts toward major contributors. Additionally, tracking of nutrient loads from the existing municipal lagoons should be done to confirm the low contribution to the lake.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Neosho Basin were held January 9, 2002 in Burlington and March 4, 2002 in Council Grove. An active Internet Web site was established at http://www.kdhe.state.ks.us/tmdl/ to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Neosho Basin.

Public Hearing: Public Hearings on the TMDLs of the Neosho Basin were held in Burlington and Parsons on June 3, 2002.

Basin Advisory Committee: The Neosho Basin Advisory Committee met to discuss the TMDLs in the basin on October 2, 2001, January 9, March 4, and June 3, 2002.

Discussion with Interest Groups: Meetings to discuss TMDLs with interest groups include:

Morris County Conservation District: August 13, 2001
Kansas Farm Bureau: February 26 in Parsons and February 27 in Council Grove

Milestone Evaluation: In 2007, evaluation will be made as to the degree of implementation which has occurred within the watershed and current condition of Council Grove Lake. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The lake will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2007-2011. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2003 which will emphasize revision of the Water Quality Management Plan. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2003-2007.

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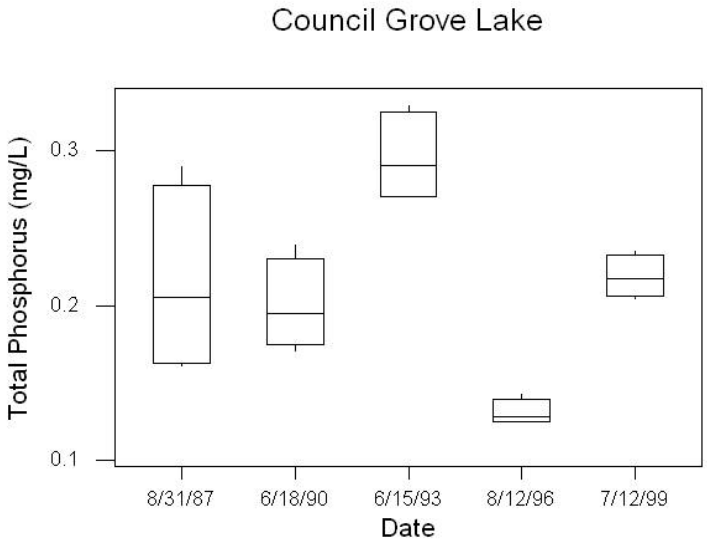
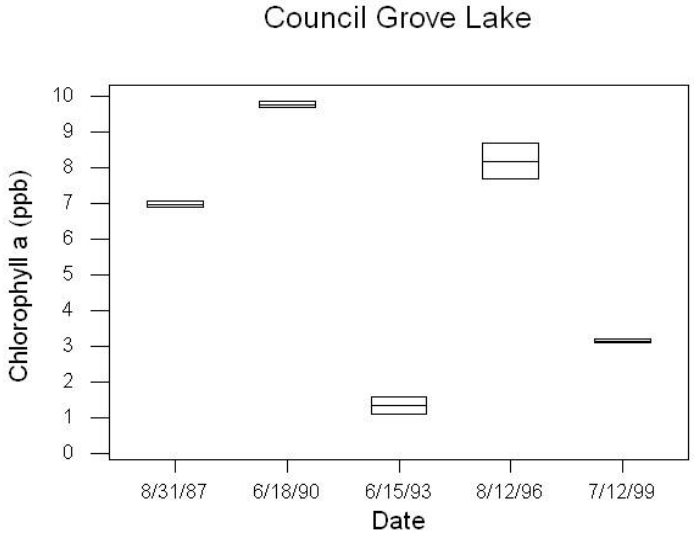
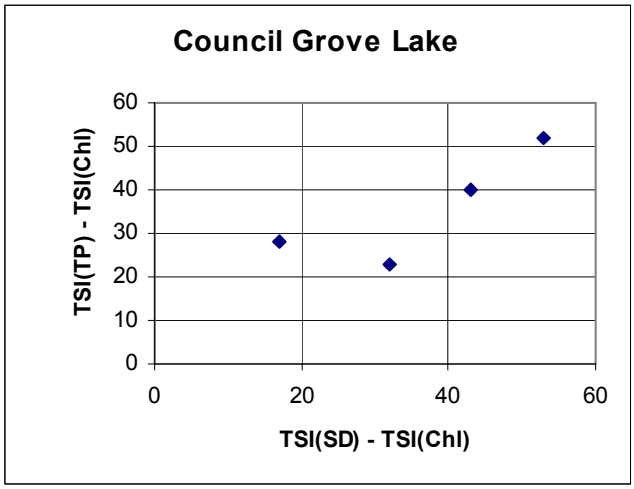
Liscek, Bonnie C. Methodology Used in Kansas Lake TMDLs [web page] Jul. 2001; http://www.kdhe.state.ks.us/tmdl/eutro.htm [Accessed 17 May 2002].

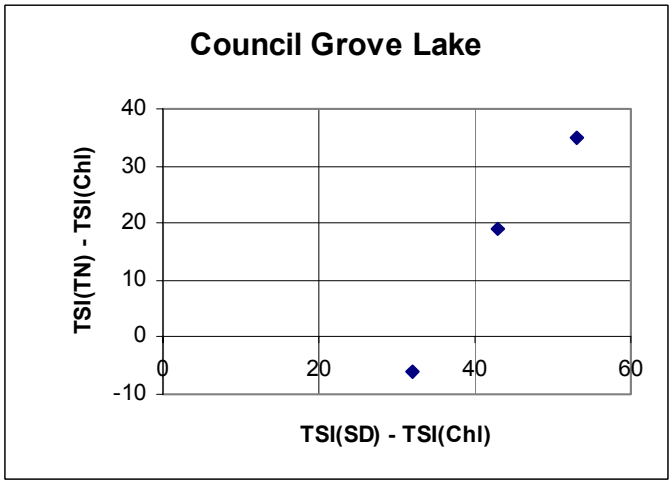
Appendix A - Boxplots





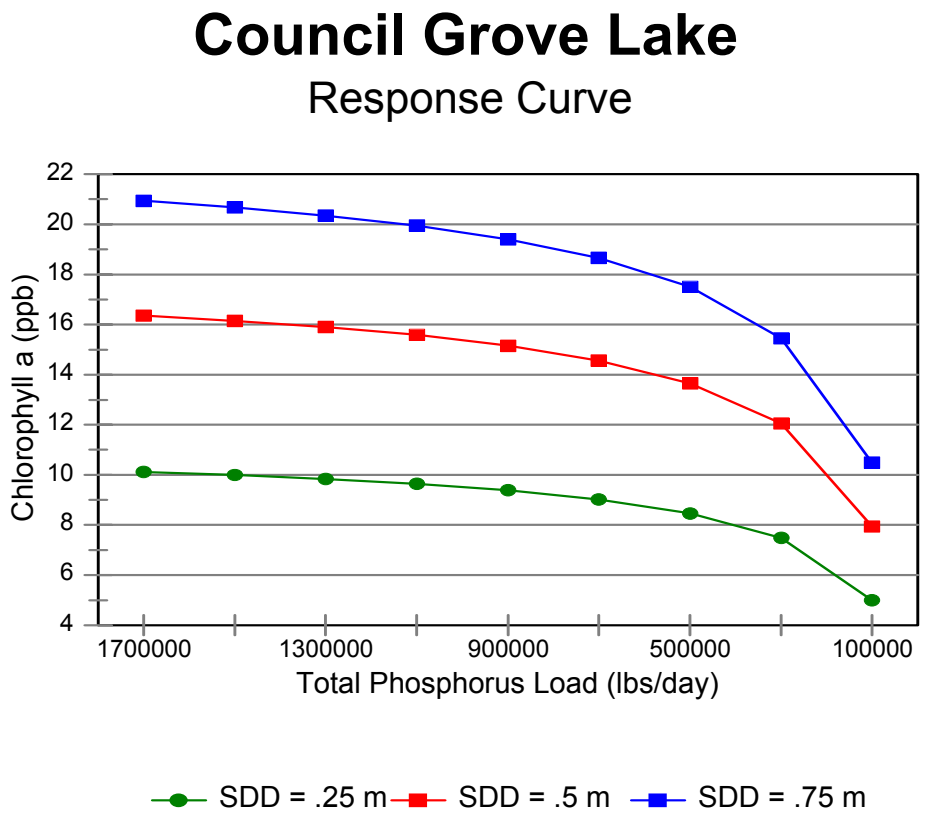
Appendix B - Trophic State Index Plots





The Trophic State Index plots indicate that light is the primary limiting factor, due to clay turbidity.

Appendix C - Response Curves



Secchi Disc Depth (SDD) is a measure of clarity in a lake. As more light is able to penetrate the water column, the growth rate of the algae and thus the chlorophyll a concentration increases. The Total Phosphorus load must be reduced simultaneously to keep the algal community from increasing to nuisance levels.

Appendix D - Input for CNET Model

Parameter	Value Input into CNET Model
Drainage Area (km^2)	669.75
Precipitation (m/yr)	0.83
Evaporation (m/yr)	1.33
Unit Runoff (m/yr)	0.17
Point Source Flow (hm^3/year)	0.369
Point Source Total P Concentration (ppb)	2000
Surface Area (km^2)	10.48
Mean Depth (m)	4.40
Depth of Mixed Layer (m)	4.17
Depth of Hypolimnion (m)	1.25
Observed Phosphorus (ppb)	211.95
Observed Chlorophyl-a (ppb)	5.90
Observed Secchi Disc Depth (m)	0.28

Output from CNET Model

Parameter	Output from CNET Model
Load Capacity (LC)*	103,094 lb/yr
Waste Load Allocation (WLA)	1,627 lb/yr
Load Allocation (LA)	91,158 lb/yr
Margin of Safety (MOS)	10,309 lb/yr

***LC = WLA + LA + MOS**

Approved September 30, 2002

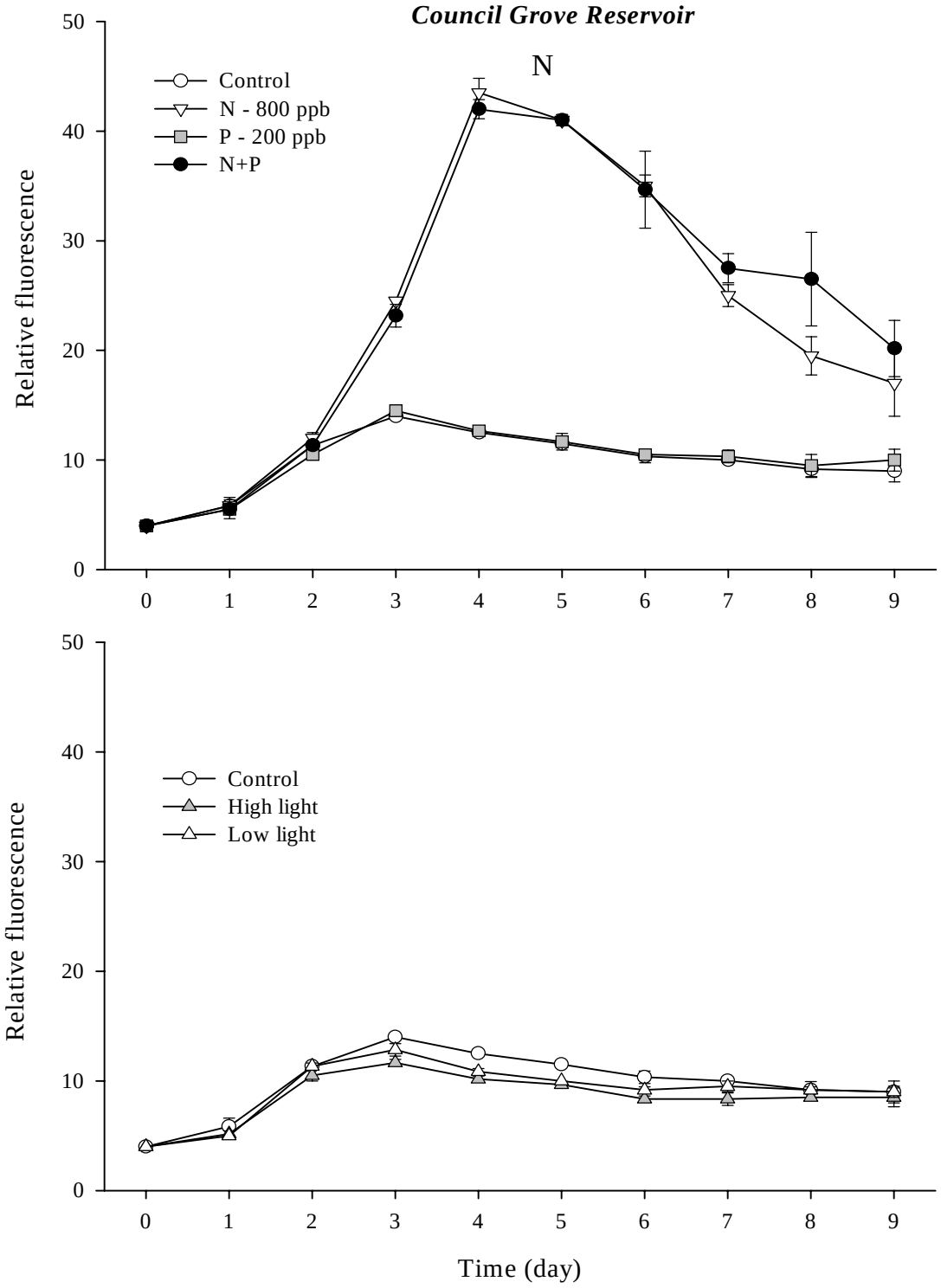


Figure 29. Bioassay results (nutrients and light) of studied reservoirs. Water samples for these experiments, which were performed in November 2000, were collected at the main basin of studied reservoirs. Source: Kansas Biological Survey.